

REMARKS

Claims 1-12 and 64-105 were initially pending in this application. Claims 4, 5 and 77 have been canceled. Claims 1-3, 6-12, 64-76 and 78-105 remain pending.

Allowable Matter

Applicants note with appreciation that claims 1-12 and 64-68 are allowed. Applicants also note that claims 3, 5, 72-74, 77, 79, 81, 82 and 88-105 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Specification

All instances of the trademark HALAR in the specification have been capitalized and are accompanied by generic terminology.

The 35 U.S.C. 112 Rejection

Claim 8 is rejected under 35 U.S.C. 112, second paragraph as being indefinite since the term “highly” is a relative term. Claim 8 is now amended to remove the term “highly.”

The 35 U.S.C. 102 Rejections

Claims 1, 2 and 7 to 10 are rejected under 35 U.S.C. 102 (b) as being anticipated by Shorr (US 3,556,305). This rejection is respectfully traversed and reconsideration is requested.

The Examiner alleges that Shorr discloses a polymeric ultrafiltration membrane incorporating PVME wherein PVME is present as a coating on the membrane, wherein the membrane is hydrophilic and has an asymmetric (layered) structure, wherein the membrane is substantially free of macrovoids and has a reduced pore size as a result of the addition of PVME.

Column 2, line 55 to 56 of Shorr discloses that *poly (methyl vinyl ether/maleic anhydrides) are useful adhesive polymers*. Further, at column 3, lines 47 to 48, refer to a diffusion-type membrane film:

There can also be used...a mixture of polyvinyl methyl ether with a copolymer of vinyl

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methyl ether with maleic anhydride.

The incorporation of PVME into an ultra or microfiltration membrane as a heterogenous or homogenous dispersion as set forth in amended claim 1 is not disclosed in Shorr, which refers only to an adhesive polymer barrier layer coated on the membrane substrate and a diffusive polymer layer bonded to the adhesive layer. Therefore, we submit that Shorr does not anticipate amended claim 1 and dependent claims 2 and 7 to 10.

Claims 1, 2 and 6 to 11 are rejected under 35 U.S.C. 102 (e) as being anticipated by Serikov (US 6,602,391 B2). The Examiner alleges that Serikov discloses a polymeric ultrafiltration membrane incorporating PVME wherein PVME is present as a coating on the membrane, wherein the polymeric membrane comprises PP, PVDF or Halar (ethylene chlorotrifluoroethylene), wherein the membrane is hydrophilic and has an asymmetric (layered) structure, wherein the membrane is substantially free of macrovoids and has a reduced pore size as a result of the addition of PVME, and wherein the membrane comprises cross-linked PVME.

The sole mention of PVME in Serikov is at column 10, line 66 to column 11, line 2 in reference to a precoating on a dense supporting membrane wherein it is stated that:

'Liquid-surfactant membranes can be precoated on a dense supporting membrane, for example by coating the membrane substrate with 0.1% solution of poly (vinyl methyl ether) in CCl₄.'

Serikov does not disclose the incorporation of PVME into an ultra or microfiltration membrane as a homogenous dispersion, as set forth by amended claim 1. Therefore, we submit that Serikov does not anticipate amended claim 1 and dependent claims 2 and 6 to 11.

Claims 1, 4, 10 and 11 are rejected under 35 U.S.C. 102 (b) as being anticipated by Gregor (US 4,033,817). The Examiner alleges that Gregor discloses a polymeric ultrafiltration membrane incorporating PVME wherein PVME is incorporated in the membrane as a homogenous dispersion, wherein the membrane is substantially free of macrovoids and wherein the membrane comprises cross-linked PVME.

Gregor discloses a film prepared from *2 parts of a copolymer of vinylmethylether and maleic anhydride* in Example 4 at column 9, line 19. The film was combined with Kynar and

dissolved in a mixture of hexamethylenephosphoramidate and DMF, a membrane being cast therefrom. The membrane was sprayed with a dry mist of toluene to cause a partial coagulation of the film such that, on drying, a highly porous film was produced. However, Gregor does not disclose PVME as present as a coating on the membrane and incorporated in the membrane as a homogenous or heterogeneous dispersion throughout the membrane as disclosed by claim 1 when amended as indicated above. We submit that Gregor does not anticipate amended claim 1 and dependent claims 4, 10 and 11.

Claims 69-71 are rejected as being anticipated under 35 U.S.C. 102(b) by Kim et al (US 6,699,611 B2). The Examiner alleges that Kim discloses a method of hydrophilising a membrane prepared from a polymeric material comprising contacting the polymeric material with a compatible at least partially water soluble polymeric hydrophilising agent containing vinyl methyl ether monomers. Kim teaches that *the amount of water in the PEM can be controlled due to the hydrophilicity and hydrophobicity of the thermo-responsive polymers upon increasing and decreasing temperatures* (column 2, lines 54 to 57) and that *PVME....polymers that show negative thermo-responsive behaviour... negative thermo-responsive polymers can be incorporated into the fuel cell as a gas diffusion layer* (column 5, lines 5 to 6 and column 5, lines 8 to 10). Further, at column 2, lines 64 to 66, Kim discloses that a thermo-responsive polymer can be added to the fuel cell via *attachment of a solid film or porous membrane as a gas-diffusion layer,...or surface functionalisation or grafting onto the membrane...*

Kim teaches that the hydrophobicity and hydrophilicity of the thermo-responsive polymers will vary with increasing/decreasing temperatures. The invention of Kim is therefore not designed to make a membrane hydrophilic for operation over a long period of time but to make the hydrophilicity of a membrane vary with varying temperatures. PVME is disclosed above as showing negative thermo-response behaviour. The method described in Kim discloses *transitioning the negative thermo-response polymer from hydrophilicity to hydrophobicity in response to the increased temperature*. In light of this, it is clear that Kim does not disclose the method of hydrophilising a membrane, rather it teaches away from the present invention, using PVME as a negative thermo-response polymer to produce a hydrophobic membrane upon application of increasing temperature.

Claims 75, 76, 78, 80 and 87 are rejected as being anticipated under 35 U.S.C. 102(b) by Kim et al (US 6,699,611 B2). The Examiner alleges that Kim discloses a method of modifying the hydrophobic/ hydrophilic balance of a polymer membrane prepared from a polymeric material, the method including the steps of contacting the polymeric material with PVME to produce a modified polymer membrane, wherein the polymeric membrane is coated with PVME, wherein the polymeric material is a formed membrane treated with a solution of PVME at a concentration and for a time sufficient to allow PVME saturation of the membrane to take place, or wherein the polymeric material is treated with PVME by means of adding PVME to a membrane dope prior to casting, and wherein the polymeric material is a hydrophobic polymer and the hydrophobic/hydrophilic balance of the polymer is modified to provide a hydrophilic modified polymer membrane.

Claim 75 has been amended to include the subject matter of claim 77 and claim 77 has been cancelled. As noted above, at column 2, lines 64 to 66, Kim discloses that a thermo-responsive polymer can be added to the fuel cell via *attachment of a solid film or porous membrane as a gas-diffusion layer, via incorporation of an interpenetrating polymer network or surface functionalisation or grafting onto the membrane*. The membrane in Kim is used in a fuel cell for such that *fuel or oxidant gas passes through the thermo-responsive polymer to the membrane electrode assembly* (column 5, lines 58 to 59). An ultrafiltration or microfiltration membrane would thus not be considered suitable for use in the invention of Kim, which is designed to *prolonging the life of a fuel cell via hydrogen and/or oxygen diffusion control*. Fuel cell membranes typically have pore sizes in the nanometer range for such purposes, which is range that an ultra or microfiltration membrane cannot be used for. We submit that Kim does not teach or suggest a method of making an ultrafiltration or microfiltration membrane hydrophilic. Therefore we believe that Kim does not anticipate amended claim 75 and dependent claims 76, 78, 80 and 87.

The 35 U.S.C. 103 Rejections

Claims 83-85 are rejected under 35 U.S.C. 103 as being unpatentable over Kim et al (US 6.699.611 B2). The Examiner alleges that, although Kim is silent as to the concentration of PVME and treatment time, a person skilled in the art would have recognised that these could have been optimised as a matter of routine experiment depending on the desired properties of the

membrane. We respectfully disagree.

The invention of Kim is a means of controlling hydration of the polymer electrolyte membrane (PEM) contained within a fuel cell. The amount of water in the system can be controlled *by taking advantage of the change in hydrophilicity and/or hydrophobicity of the thermo-responsive polymer upon change in temperature during fuel cell operation* (column 3, lines 2 to 5). The use of PVME in Kim is as a negative thermo-responsive polymer forming the gas-diffusion layer (column 5, lines 5 to 22). The stated purpose is to allow less hydrogen and/or oxygen to come through upon contraction i.e. diffusion of gas becomes slower upon increasing use of fuel cell; beneficial in prolonging the life cycle of a fuel cell but not necessarily maximum performance (column 5, lines 14 to 20).

The applicants of the present invention have found that PVME may be used to modify, in particular reduce, the hydrophobicity of certain hydrophobic membranes (page 4, lines 18 to 20 of present specification. On page 9, lines 21 to 25 of the present specification it is stated that:

PVME was surprisingly found to be effective at hydrophilising otherwise hydrophobic...membranes by soaking the membrane as a post treatment or by including the PVME as a hydrophilising agent incorporated in the membrane dope.

There is no teaching or suggestion in Kim that a particular concentration of PVME will modify a hydrophobic membrane to provide hydrophilic properties, since the object of Kim is to change the hydrophobic/hydrophilic balance of the PEM upon application of temperature rather than a particular concentration of polymer. This is one reason that, as the Examiner acknowledges, Kim is silent as to the concentration of PVME. As this particular application is to membranes as used in fuel cells, there is no teaching or suggestion in Kim for a person skilled in the art of ultra or microfiltration membranes, which generally have larger pores than a membrane used in a fuel cell, to determine the concentration or exposure time of PVME to modify a hydrophobic membrane to make it hydrophilic. Indeed, the method of claim 4 in Kim discloses *transitioning the negative thermo-response polymer (i.e. PVME) from hydrophilicity to hydrophobicity in response to the increased temperature*. We submit that Kim would actually teach away from using any concentration of PVME for any length of time to obtain the object of the present invention.

Further, it was surprisingly found that the concentration of PVME appears unimportant provided it is above the critical value of 0.1%. Rather than the expected result of higher concentration of PVME resulting in greater hydrophilicity, it was surprisingly found that PVME adsorption by the membrane was limited by the surface area available for the saturation of the membrane to take place, regardless of PVME concentration (page 14, lines 5 to 8). This is particularly relevant to maintaining hydrophilicity of the membrane over a period of time (page 10, lines 3 to 5). Therefore, it is believed that claims 83-85 are not obvious.

Claim 86 is rejected under 35 U.S.C. 103 as being unpatentable over Kim et al (US 6,699,611 B2) in view of Greenwood et al (US 6,056,903). The Examiner alleges that, while Kim does not explicitly recite a rinsing stage to remove unbound PVME, Greenwood teaches a similar method including a rinsing step to remove a coating material and solvent. We respectfully disagree. Greenwood simply states at column 5, lines 22 to 24 that the *membrane is rinsed free of any residuals and dried using known techniques*. Greenwood, therefore, does not indicate that unbound coating particles are removed, simply ‘residuals’ which may easily be residual solvent species, for example, from the production process. Further, Greenwood says at column 5, lines 50 to 52 that *the membrane is relatively free of unattached polymer particles*

Further, as long as the PVME of Kim is ‘proximate’ (i.e. may or may not be attached) to the membrane–electrode assembly (as set forth in Kim), it does not matter whether it is bound or unbound to the membrane structure itself. As such, the membrane in Kim does not require rinsing to remove unbound PVME. Thus, Kim actually teaches away from the need to rinse the membrane to remove unbound polymer particles. Therefore, it is believed that claim 86 is not obvious.

Should the Examiner be of the view that an interview would expedite consideration of this Amendment or of the application at large, request is made that the Examiner telephone the applicant’s attorney at (732) 321-3193 in order that any outstanding issues be resolved. While it is believed that no additional fee is due, the undersigned authorizes the charging of any fee deficiency that is due to Deposit Account No. 19-2179.

Respectfully submitted,

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